CLAIMS

What is claimed is:

1. A fluxing curative for curing an underfill that comprises an epoxy resin and for fluxing a solder during a solder assembly of an electronic component to an electronic device substrate, the fluxing curative comprising a salt that is a reaction product of an imidazole component and a carboxylic acid component having at least 10 carbon atoms per molecule.

2. The fluxing curative of claim 1 wherein the imidazole component is selected from the group consisting of imidazole, isoimidazole, and a substituted imidazole.

3. The fluxing curative of claim 1 wherein the imidazole component is selected from an alkyl-substituted imidazole and an aryl-substituted imidazole.

4. The fluxing curative of claim 1 wherein the imidazole component is selected from an alkyl-substituted imidazole having up to about 17 carbon atoms in the alkyl substituent and an aryl-substituted imidazole having up to about 10 carbon atoms in the aryl substituent.

5. The fluxing curative of claim 1 wherein the imidazole component is selected from an alkyl-substituted imidazole having up to about 8 carbon atoms in the alkyl substituent and an aryl-substituted imidazole having up to about 10 carbon atoms in the aryl substituent.

6. The fluxing curative of claim 1 wherein the imidazole component is an alkyl-substituted imidazole selected from the group consisting of 2-methyl imidazole, 2-ethyl-4-methylimidazole, 2,4-dimethylimidazole, butylimidazole, 2-undecenylimidazole, 1-vinyl-2-methylimidazole, 2-n-heptadecylimidazole, 2-undecylimidazole, 2-heptadecylimidazole, 1-propyl-2-methylimidazole, 1-cyanoethyl-2-methylimidazole, 1-cyanoethyl-2-ethyl-4-methylimidazole, 1-cyanoethyl-2-undecylimidazole, 1-cyanoethyl-2-phenylimidazole, 1-guanaminoethyl-2-methylimidazole, addition products of an imidazole and trimellitic acid, and 2-n-heptadecyl-4-methylimidazole.

7. The fluxing curative of claim 1 wherein the imidazole component is

selected from the group consisting of 2-ethyl 4-methyl imidazole and 1-cyanoethyl-2-ethyl 4-methyl imidazole.

8. The fluxing curative of claim 1 wherein the carboxylic acid component is a monocarboxylic acid having more than 15 carbon atoms per molecule, a dicarboxylic acid having at least 10 carbon atoms per molecule, or a combination thereof.

9. The fluxing curative of claim 1 wherein the carboxylic acid component is a monocarboxylic acid having more than 20 carbon atoms per molecule, a dicarboxylic acid having at least 12 carbon atoms per molecule, or a combination thereof.

10. The fluxing curative of claim 1 wherein the carboxylic acid component is a dicarboxylic acid having at least 20 carbon atoms per molecule.

11. The fluxing curative of claim 1 wherein the carboxylic acid is isostearic acid, 5-n-hexyl-2-(carboxyl-n-heptyl) cyclohex-3-ene carboxylic acid, or a combination thereof.

12. The fluxing curative of claim 1 wherein the salt comprises a weight ratio of the imidazole component to the carboxylic acid that is between about 1:0.1 to 1:4.

13. The fluxing curative of claim 1 wherein the salt comprises a weight ratio of the imidazole component to the carboxylic acid that is about 1:2.

14. The fluxing curative of claim 1 wherein the fluxing curative is substantially free of an anhydride.

15. A method of preparing a salt that is used for curing an underfill that comprises an epoxy resin component and for fluxing a solder during a solder assembly of an electronic component to an electronic device substrate, the method comprising mixing an imidazole component with a carboxylic acid component having at least 10 carbon atoms per molecule at a temperature and for a duration sufficient to form the salt.

16. The method of claim 15 wherein the temperature is between about 20 °C and about 100 °C and the duration is between about 5 minutes and about 48 hours.

17. The method of claim 15 wherein the temperature is between about 60 °C and about 70 °C and the duration is between about 1 hour and 12 hours.

18. An underfill solution for application between an electronic component and an electronic device substrate to assist in solder assembly of the electronic component to the electronic device substrate and to provide mechanical shock resistance and thermal cycling resistance, the underfill solution comprising an epoxy resin component and a fluxing curative for curing the epoxy resin component and for fluxing a solder during the solder assembly, the fluxing curative comprising a salt that is a reaction product of an imidazole component and a carboxylic acid component having at least 10 carbon atoms per molecule.

19. The underfill solution of claim 18 wherein the epoxy resin component is at a concentration that is between about 20 and about 95 weight percent of the underfill solution and the fluxing curative is at a concentration that is between about 1 and about 30 weight percent of the underfill solution.

20. The underfill solution of claim 18 wherein the epoxy resin component is at a concentration that is between about 65 and about 75 weight percent of the underfill solution and the fluxing curative is at a concentration that is between about 1 and about 30 weight percent of the underfill solution.

21. The underfill solution of claim 18 wherein the imidazole component is at a concentration that is between about 0.1 and about 9 weight percent of the underfill solution.

22. The underfill solution of claim 18 wherein the imidazole component is at a concentration that is between about 2 and about 7 weight percent of the underfill solution.

23. The underfill solution of claim 18 wherein the carboxylic acid component is at a concentration that is no greater than about 15 atomic percent of the underfill solution.

24. The underfill solution of claim 18 wherein the carboxylic acid component is at a concentration that is between about 2 and about 12 atomic percent of the underfill solution.

25. The underfill solution of claim 18 wherein the carboxylic acid component is at a concentration that is between about 5 and about 10 atomic percent of the underfill solution.

26. The underfill solution of claim 18 wherein the epoxy resin component is selected from the group consisting of a diglycidyl ether of bisphenol A, a diglycidyl ether of bisphenol F, a triglycidyl ether of triphenomethane, a polyglycidyl ether of novolac, a polyglycidyl ether cresol novolac, a polyglycidyl ether of napthalenic phenol, and methyl, ethyl, propyl, and butyl substituted versions thereof.

27. The underfill solution of claim 18 wherein the epoxy resin component comprises diglycidyl ether of bisphenol F, a triglycidyl ether of triphenomethane, and a polyglycidyl ether cresol novolac.

28. The underfill solution of claim 18 comprising a wetting agent selected from the group consisting of a silane, a fluorocarbon, and an acrylate resin, wherein the wetting agent is at a concentration that is between about 0.005 and about 2.0 weight percent of the underfill solution.

29. The underfill solution of claim 18 comprising a defoaming agent comprising a polyether modified siloxane, a methylalkyl siloxane, or a combination thereof, wherein the defoaming agent is at a concentration that is no more than about 1 weight percent of the underfill solution.

30. The underfill solution of claim 18 comprising a silane coupling agent comprising organomodified silicone molecules, wherein the silane coupling agent is at a concentration that is between about 0.05 to about 2 weight percent of the underfill solution.

31. The underfill solution of claim 18 comprising a toughening agent, the toughening agent comprising submicron particles of a silicone resin selected from the group consisting of a silicon resin, an acrylic based core shell rubber, and a carboxyl terminated butadiene resin , wherein the toughening agent is at a concentration that is between about 0.5 and about 30 weight percent of the underfill solution.

32. The underfill solution of claim 18 comprising a leveling agent selected from the group consisting of a fluorosurfactant, an organomodified silicon, and an acrylic, wherein the leveling agent is at a concentration that is between about 0.01 and about 1.2 weight percent of the underfill solution.

33. The underfill solution of claim 18 comprising a CTE modifier selected from the group consisting of beryllium oxide, aluminum oxide, aluminum nitride, silicon carbide, silicon dioxide, a low expansion ceramic powder, and a low expansion glass powder, wherein the CTE modifier is at a concentration that is between about 10 and about 90 weight percent of the underfill solution.

34. The underfill solution of claim 18 wherein the epoxy resin component comprises a diglycidyl ether of bisphenol F at a concentration that is between about 50 and about 70 weight percent, a triglycidyl ether of triphenomethane at a concentration that is between about 5 and about 10 weight percent, and a polyglycidyl ether cresol novolac at a concentration that is between about 2 and about 8 weight percent, the salt is at a concentration that is between about 5 and about 20 weight percent, and wherein the underfill solution comprises a leveling agent at a concentration that is between about 0.1 and about 1 weight percent, a wetting agent at a concentration that is between about 0.1 and about 1 weight percent, a toughening agent at a concentration that is between about 5 and about 10 weight percent, and a silane coupling agent at a concentration that is between about 0.1 and about 1 weight percent.

35. The underfill solution of claim 18 being substantially free of an anhydride.

36. A method for attaching an integrated circuit device having at least one solder bump on a surface thereof to a circuit board having at least one metal pad on a surface thereof by soldering, the method comprising:

applying an underfill solution to the surface of the circuit board such that the underfill solution is in contact with the at least one metal pad, wherein the underfill solution comprises an epoxy resin component and a fluxing curative for curing the epoxy resin component and for fluxing the at least one solder bump, the fluxing curative comprising a salt that is a reaction product of an imidazole component and a carboxylic acid component having at least 10 carbon atoms per molecule;

placing the integrated circuit device onto the circuit board to yield a circuit board with the integrated circuit device placed thereon; and

heating the circuit board with the integrated circuit device placed thereon to a reflow temperature to melt and flux the at least one solder bump, to flow the underfill, and to cure the epoxy resin thereby yielding a circuit board having the integrated circuit device attached thereto with a solder connection and a cured underfill.

37. The method of claim 36 wherein the reflow temperature is less than about 300 °C.

38. The method of claim 36 wherein the reflow temperature is between about 220 °C and about 260 °C.

39. The method of claim 36 wherein the reflow temperature is between about 170 °C and about 225 °C.

40. The method of claim 36 wherein the solder is selected from the group consisting of lead-containing solder alloys and lead-free solder alloys.

41. The method of claim 36 wherein the underfill solution is substantially free of an anhydride.